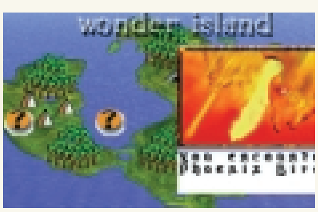
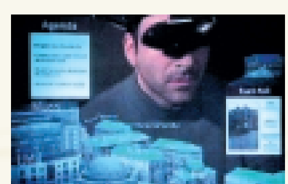
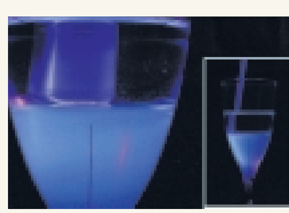
Emerging Technologies

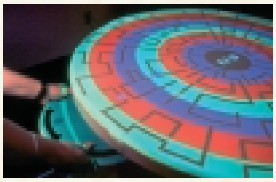
Chair

Mk Haley
Walt Disney Imagineering









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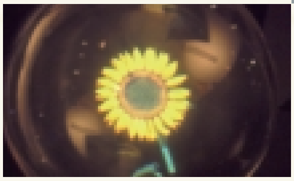

Introduction

> "It's kind of fun to do the impossible."
> *- Walt Disney*

Welcome to Emerging Technologies for SIGGRAPH 2001!

Emerging Technologies is always a dynamic collage of hardware, software, and visions into the world of computer graphics and interactive techniques. This year, we celebrate not only the technology we develop to play, but also the play we all enjoy in exploring the challenge of continually advancing the field, inventing entirely new archetypes, and tackling design issues. From lab prototypes to student research projects and industry beta tests, Emerging Technologies allows you to get your hands on, and your head around, some truly unique visions of the future of technology, as well as some solid examples of the state of the art right now. Everything from display systems to interfaces, robotics, collaboration, simulation, music, and online applications is available for exploration. With submissions from around the world, from a diverse array of fields, I hope that you not only have fun, but that you also see exciting visions of the future that inspire you to think about the effect your work will have in the future of emergent technologies.

Mk Haley
SIGGRAPH 2001 Emerging Technologies Chair
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α Wolf

Chair's Prerogative Exhibit

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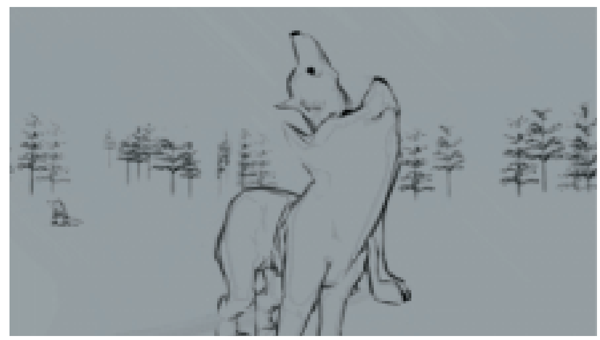
AlphaWolf presents a synthetic wolf pack comprised of autonomous and semi-autonomous wolves who interact with each other much as real wolves do, forming dynamic social relationships based on their past experiences. How the wolves interact is determined by their internal state, their social positions in the pack, and their previous experiences with their pack-mates. Each of several participants can affect the emotional state of a wolf by howling, growling, or whimpering into a microphone. In addition, participants can encourage their wolves to interact with specific other wolves in the pack. By letting participants "get inside the mind and body" of a wolf, AlphaWolf provides a compelling opportunity to explore the meaning of social behavior.

This work is informed by the biology and behavior of the gray wolf (*Canis lupus*). In their natural environment, wolves form hierarchical social relationships within their packs. Certain individuals are dominant over other individuals. To demonstrate and maintain these relationships, wolves exhibit stereotypical dominance and submission behaviors toward each other. These social behaviors appear to be derived from other behavioral patterns exhibited by wolves. For example, the two main forms of submission in adult wolves (passive submission and active submission) are quite similar to two forms of pup behavior (reflex urination and food-begging). AlphaWolf explores the connections among social behavior, learning, emotion, and development in virtual wolves to create an entertaining interaction and shed some light on those connections in wild wolf populations.

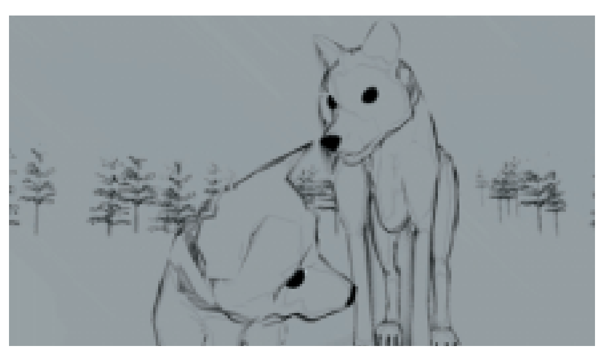
Since most people interacting with AlphaWolf are novices, it's best to "play" wolf puppies in the beginning. As new additions to the pack, novices, and pups have about the same level of social skills. Just as puppies are tolerated by adult wolves when they behave in ways that are socially inappropriate, novice users should be welcomed into the system despite their limited knowledge of wolf social behavior. Virtual pups should learn at the same rate as the human interactors, so that the two are well matched as they proceed through the social environment together.

AlphaWolf represents the second year of a multi-year project by the Synthetic Characters Group at the MIT Media Lab under the direction of Bruce Blumberg. Through this project, we aim to develop autonomous animated characters whose behavioral complexity, ability to learn and adapt, expressivity, and intentionality rival those of a real dog or wolf. In addition to extending our previous work, AlphaWolf explores the computational representations that must be in place to enable social learning and formation of context-specific emotional memories. The installation showcases the minds and bodies of the wolves themselves and features a suite of supporting technology, including evocative real-time computer graphics, autonomous cinematography, and dynamic scoring and sound design.



The alpha wolf and his pup howl together.

The pup tries to convince the alpha wolf to play.



The pup submits to the alpha wolf.

CircleMaze
Juried Exhibit

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The CircleMaze, developed at Carnegie Mellon University's Entertainment Technology Center, is a multi-user interactive musical game that encourages team building and collaboration. Combining novel input devices with real-time computer graphics on an integrated tabletop surface, the CircleMaze brings together a group of players to participate in group gaming and music-making. Each player has a rotating circular disk that serves as an input device to control audiovisual aspects of the game.

Goals
The CircleMaze is a spin-off from the Jam-O-Drum (SIGGRAPH 2000), which was developed at Interval Research between July 1998 and January 1999 under the direction of Tina (Bean) Blaine. The Jam-O-Drum used the metaphor of a digital community drum circle to give novice musicians the experience of ensemble music making in a casual social setting with real-time video and computer graphics. Expanding on this early primarily rhythmic input prototype, we have developed a new interactive gaming experience.

The CircleMaze is a game that furthers communication and collaboration among its players. The task for the players is to guide all of the game's pieces to the middle of the maze. Because the maze is divided into concentric rings, the pieces must pass through each ring in turn to go from the outer edge of the circular table to the center, so all the players must work together to achieve this goal. Movement of the pieces and rings produces changes in the musical score. As players turn their rings, they alter their sonic contribution to the ensemble. Players of the CircleMaze are involved in a goal-oriented game that requires them to work together as collaborative DJ's to affect musical tracks as their disks spin.

No musical experience is required, because any movement of the rings produces a complementary musical effect. It is our hope that people who might ordinarily be inhibited about participating in a public musical activity will approach the CircleMaze simply because of its game-like interaction and engaging appearance. Afterward, participants might realize that they have also been playing an unusual instrument.

Future Potential
The CircleMaze is a single step in our continuing research into communal music-making experiences. Several larger research questions remain, such as: How does one encourage spontaneous, non-self-conscious music-making? How does one facilitate real-time collective experiences among strangers? How does one best introduce an inexperienced player to the world of music-making?

We continue to explore interaction designs and input devices that integrate a variety of approaches to combining elements of motion in music and graphics. The CircleMaze is the latest in what we hope is a long series of experiences derived from the Jam-O-Drum.

Exhibition
- The Jam-O-Drum is currently a permanent installation at the Experience Music Project in Seattle.
- The Jam-O-Drum was exhibited at Emerging Technologies, SIGGRAPH 2000.
- In 2001, the CircleMaze is included in a museum-wide exhibit on gaming at the Zeum Youth Art and Technology Center at Yerba Buena Gardens, San Francisco.

Cylindrical 3D Display Observable from All Directions

Juried Exhibit

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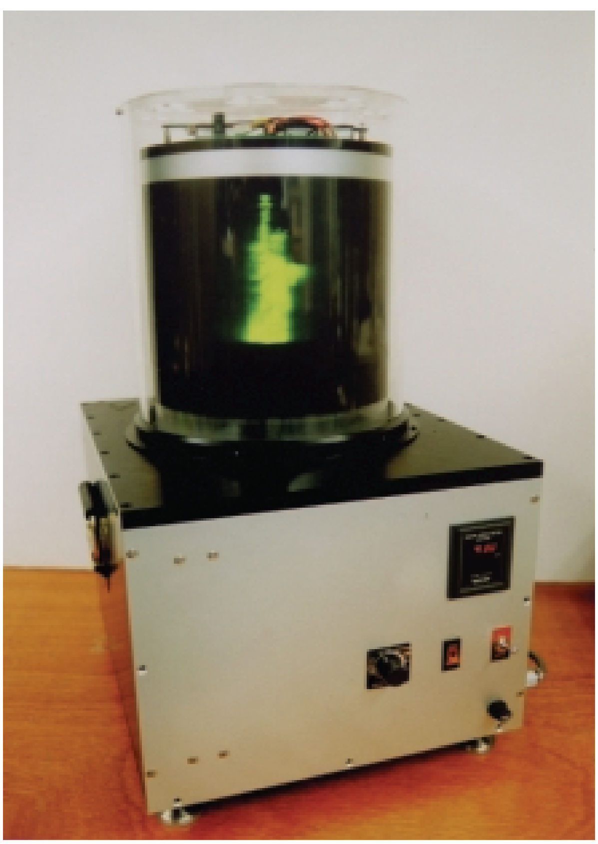
This new cylindrical 3D display allows multiple viewers to see 3D images from 360 degrees of arc horizontally without special glasses. The display is based on ray-space and super-multiview concepts, so its images have smooth motion parallax with unlimited viewing distance.

Cylinder-shaped holographic stereograms are widely used for art, advertising, and other applications because they allow multiple viewers to see a 3D image from all directions. But a multiplex-hologram can only show static images. Some displays of volumetric scans can show dynamic images that can be viewed from all directions, but their application is limited because they display "phantom images," in which all of the background objects are translucent. On the other hand, due to resolution limitations and the shape of 2D display devices such as LCD panels, it is difficult to make a multiview display with conventional methods such as lenticular sheets so that the display can be seen from all horizontal directions.

Our technique uses a cylindrical parallax barrier and a one-dimensional light-source array constructed from semiconductor light sources such as LEDs aligned vertically. It is based on the parallax panoramagram. The light source array rotates along the inside of the cylindrical parallax barrier, and the intensity of each light is modulated synchronously with the rotation.



Enhanced Reality: A New Frontier for Computer Entertainment

Juried Exhibit

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Enhanced reality is a new form of computer entertainment that combines live video and computer graphics to produce real-time, movie-like special effects. Because the user is directly involved, enhanced reality can be more personalized and more engaging than traditional computer entertainment (video games). In the enhanced reality demonstrations of this exhibit, participants interact with a virtual character, play with virtual butterflies, interact with virtual crawling spiders, and engage in magic duels.

Enhanced reality is targeted specifically at home computer entertainment, for use in a typical living room or family room environment. When necessary, participants use simple props to enhance the interaction process; this enables a successful user experience despite the unstructured background and widely varying lighting conditions.

The techniques used to achieve enhanced reality fall into two categories:

1. Interpretation, which consists of processing video input to extract information about the participant and the environment, such as the 3D position of special props or a model of the lighting of the scene.

2. Enhancement, which consists of modifying the video image to produce a desired effect, such as rendering synthetic objects that look real.

This work is implemented on PlayStation 2 and displayed on a standard TV set. An inexpensive (<$100) IEEE 1394 Webcam is used for video input. The interaction props are simple plastic and/or foam toys.

Participant plays with a virtual pet.

Participant interacts with a virtual character.

EnhancedDesk

Juried Exhibit

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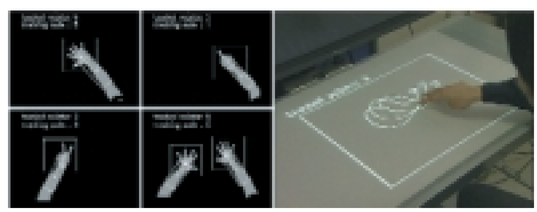
Experiments with tangible objects, interaction with computer simulations, electronic-media databases, and paper-based materials are common tools for wide varieties of tasks in offices and classrooms. This richness of semi-connected content leaves us with the burden of media synchronization. For example, the overhead of accessing a computer simulation mentioned in a printed book often disrupts the train of thought. A simple dictionary search on the Web while reading a book requires a series of operations that shifts our focus of attention.

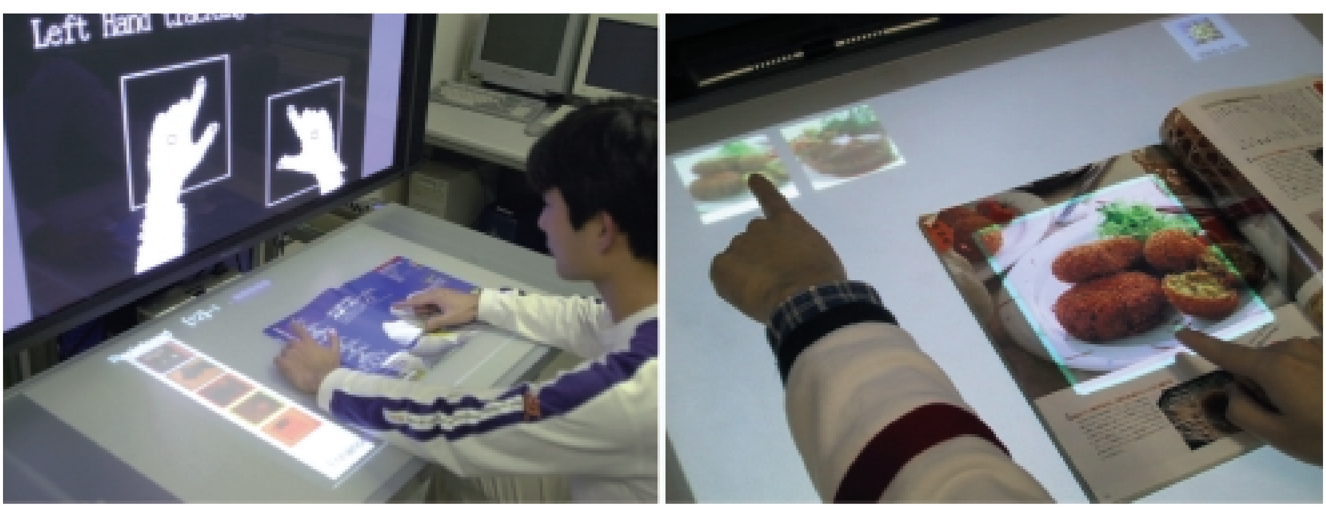
This augmented-desk system novel man-machine interfaces based on direct manipulation of both real and projected objects with hands and fingers. The key technical innovations of the EnhancedDesk include fast, accurate tracking of multiple hands and fingers, interactive object registration and recognition of hand gestures, and overlay of interactive functionality.

When this augmented-desk interface system is put to practical use, it will revolutionize the way people use computers in every aspect of their daily lives. For instance, multimedia materials can be used more effectively for study. An enormous amount of information available on the Internet could be more easily combined with physical objects such as paper documents. And EnhancedDesk's intuitive and interactive management of computer applications will provide assistance to many people who would otherwise have problems using a computer.

This work is partially funded by a research grant from Intel Corporation and the Ministry of Education, Culture, Sports, Science, and Technology.



Real-time tracking of multiple hands and fingertips.



Interactive object registration and recognition.

Everywhere Displays

Juried Exhibit

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Pervasive computing envisions a world where it is possible to connect anytime and anywhere to all the devices and services that are linked by the Internet. Since most data present in the Internet today are designed to be accessed through a high-resolution graphical interface, to truly pervasively compute we have to carry laptops everywhere, wear computer graphics goggles, or install monitors and displays on the surfaces of spaces and objects and furniture.

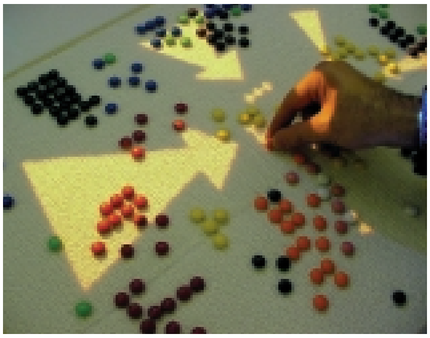
Everywhere Displays (ED) explores an alternative approach to providing a graphical interface for pervasive computing. The idea is to couple an LCD projector to a motorized rotating mirror and a computer graphics system that can correct the distortion caused by oblique projection. As the mirror moves, different surfaces become available for displays. The display also uses computer-vision techniques to detect user hand interaction (such as pointing and clicking) with the projected image.

The goal is to develop a projection-based system that creates displays everywhere in an environment by transforming surfaces into projected "touch screens." An Everywhere Displays projector can be installed on the ceiling of a space to provide a generic computer interface to users in an environment. For example, an ED projector in a store can transform pieces of white cardboard attached to shelves into interactive displays for product information. Similarly, an ED projector could be used in a home kitchen to access information, watch TV, read recipes, or simply set and control cooking time.

Everywhere displays propose a shift int he display paradigm where the display ceases to be regarded as a device to be installed in an environment or carried along by a user and becomes a service provided by a space. But like any paradigm shift, ED projectors not only solve a problem but also create a new set of applications. For instance, if information about the location and identity of objects in an environment is known, an ED projector can be used as a device to augment reality, without goggles! It can lead visitors to their destinations in a building by projecting arrows on the floor.

When visitors enter the space, they encounter an incomplete M&M picture and an invitation to interact projected beside the picture. When they touch the projected area to select an M&M color, the projector redirects its projection to point to the bin that contains M&Ms of that color. Visitors go to the bin indicated by the projector, pick up some M&Ms from the bin, and come back to the picture area. The projector points to the precise location where the M&M "pixels" should be placed. As visitors go through the exhibit, the picture emeres from their combined individual work.

A prototype of the Everywhere Displays projector.



An M&M is put in place with the help of the Everywhere Displays projector.

Excerpts from Experiments in the Future of Reading

Juried Exhibit

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XFR: Experiments in the Future of Reading is a museum installation that explores how reading might change in the near future. Featuring 11 interactive exhibits, XFR was designed by researchers in the RED (Research on Experimental Documents) group at Xerox PARC to give museum visitors an opportunity to explore a range of new reading devices.

Reading is intrinsic to how we share knowledge; entertain ourselves; and manage social, political, economic, and educational systems. Reading is also greatly influenced by technologies of various sorts: writing, authoring, presentation, publication, and distribution. XFR presents several speculations on how reading might change with the development of new media and digital technologies.

The physical form of the reading device affects our interpretation of what we read, as does the mode of interactivity. Digital technologies enable design of complex and novel reading technologies, as well as creation of new textual forms and genres. While many people envision a future dominated by hand-held reading devices, RED speculates that the future will include a wide variety of reading technologies.

For SIGGRAPH 2001 Emerging Technologies, RED exhibits three of the 11 XFR experiments:

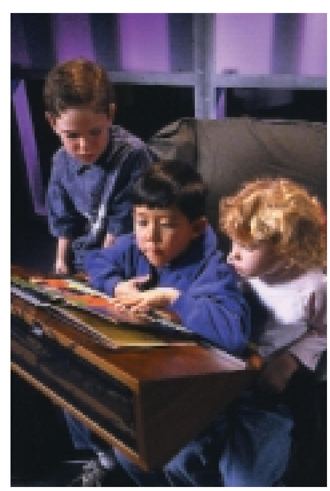
Listen Reader
The Listen Reader preserves the tactile pleasure of reading a paper-based book. In this case, books are augmented with digital soundtracks that are activated by the (sensed) position of the reader's hands on a page. Readers conduct the book's soundtrack with hand gestures.

Speeder Reader
Speed reading combined with speed racing. Using a new speed-reading protocol that presents text one word at a time, this exhibit allows visitors to modulate the speed of presentation. Children are especially excited by the idea of driving through a text. For adults, the familiar driving interface offers readers an intuitive interaction with an unusual mode of text presentation.

Tilty Tables
Reading is generally thought of as low-energy, static, solitary, and contemplative, engaging the mind more than the body. In designing Tilty Tables, RED wanted visitors to think about how the body can be engaged in the act of reading, especially when reading large documents.

Children reading "The Peace Table."

Speed reading "Podkayne's World."



Reading and listening to "Frank Was A Monster Who Wanted To Dance."

FEELEX

Juried Exhibit

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In developing and demonstrating haptic interfaces that generate skin and muscle sensation, including sense of touch, weight, and rigidity, we have found that some of them do not convey the presence of virtual objects through haptic sensation. There are two reasons for this phenomenon:

1. Our haptic interfaces allow users to touch virtual objects at a single point or a group of points. This hardware configuration cannot create realistic sensations comparable to hand manipulation in the real world.

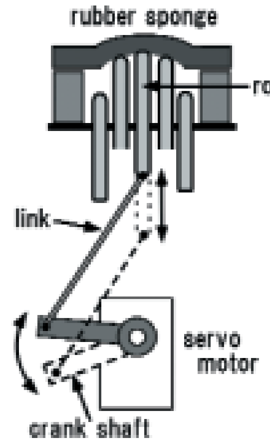
2. Visual images are combined with haptic interfaces using conventional CRT or projection screens, so users have to integrate inputs from two different displays.

We designed a new haptic-visual display to overcome these limitations. The device is composed of a flexible screen, an array of actuators, and a projector. The flexible screen is deformed by the actuators to simulate shapes of virtual objects. Images of the virtual objects are projected on the surface of the flexible screen. This configuration enables users to touch the images directly with their bare hands. The actuators are equipped with force sensors to measure force applied by users. The virutal object's hardness is determined by the relationship between the measured force and the position of the actuators.

The newest FEELEX has a high-resolution haptic surface. The distance between the actuator rods is 8 mm. This resolution enables users to hit at least one actuator when they touch any position on the screen. The screen size (50 mm X 50 mm) allows users to touch the surface with three fingers. In order to realize 8 mm resolution, a piston-crank mechanism is employed for the linear actuator.

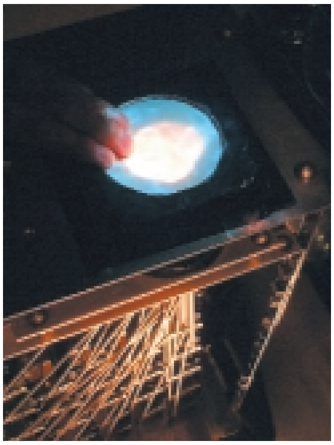
Since the motor is much larger than 8 mm, the motor should be placed at an offset position from the rod. A piston-crank mechanism can easily achieve this offset position. The flexible screen is made of rubber sponge supported by 23 rods. The rods push the rubber sponge to increase the hardness of virtual objects. This mechanism has an advantage in presentation of soft objects. The user feels a hard object submerged in a soft object. The actuators have force sensors that detect applied force from the user. If the user pushes the hard object, it moves according to the pressure. The device can be applied to a palpation simulator, a haptic touch screen, or virtual clay.

intron.kz.tsukuba.ac.jp



Mechanical configuration of an actuator

Overall view of the system



Projected image on the flexible screen

i-ball: Interactive Information Display Like a Crystal Ball

Juried Exhibit

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This object-oriented spatial display, i-ball (interactive/information ball), is spherical and transparent, so it looks like a crystal ball and is very attractive and expressive. The system is designed to capture and process images of observers' behavior, which enables not only interactive displays, but also image communication through the transparent ball.

Characteristics

- The images displayed within the transparent ball are slightly distorted by the optical system. This distortion provides the illusion of depth sensation, though it is essentially a 2D display system.
- By capturing viewer behavior, the system can display images interactively.
- When users rotate the ball, the system can display objects for any point of view.

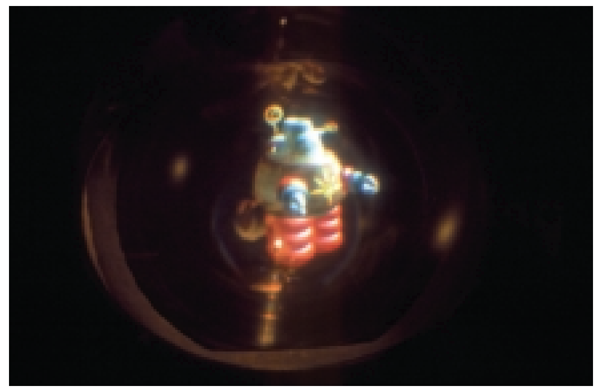
Interactive Application

As the observer's hand moves, a 3D animation is rendered, and the ball is rotated appropriately. For example:

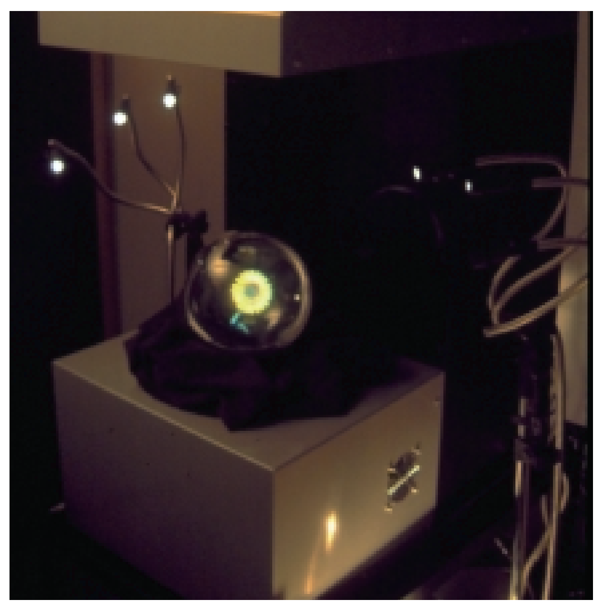
- If you wave your hand to a robot in the ball, he waves back to you.
- If you suddenly stretch your hand toward the ball as if you are punching it, the robot break into pieces.
- If you cover the ball with your hands, the robot objects and shakes his head, and the ball rotates right and left.
- If your hand moves from right to left, the ball rotates and the robot jumps to the surface of the ball.

Video Conferencing Application

Since i-ball is capable of displaying real images as well as CG, various interactions can be designed for this system. For example, i-ball can be utilized as a video conferencing application. The mirror in the ball does double duty as a reflector for both displaying objects and capturing viewer's behavior, so the optical system can easily recognize gaze awareness. Furthermore, distant particpants can control the direction of the ball, so it appears as if they are turning their heads during the communication.



Let's interact with the robot inside the transparent ball.



The i-ball system.

IllusionHole
Juried Exhibit

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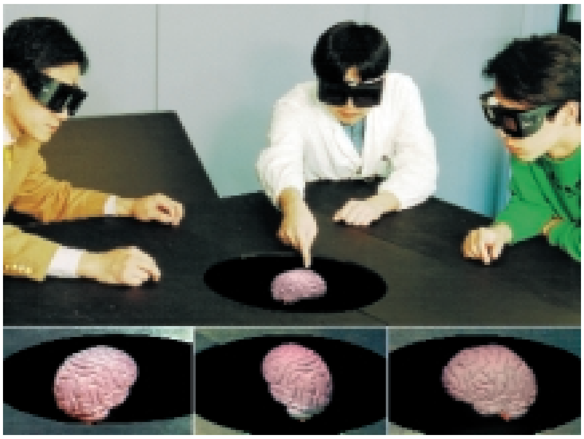
This interactive display system allows three or more moving observers to simultaneously observe stereoscopic image pairs from their own viewpoints. With a simple configuration, it provides intelligible 3D stereoscopic images free of flicker and distortion. The system consists of a normal display and a display mask, which has a hole in its center. The system tracks the head positions of all the users and generates distortion-free images for each eye of each user. Because the system controls the position of the image-drawing area for each user according to the corresponding user's viewpoint, each user can observe the stereoscopic image pairs shown in an individual area of the display system with shutter glasses.

IllusionHole is useful for applications in which several people work together to perform tasks or enjoy entertainment with a multiplier effect. A complicated set of data that is difficult for a single user to understand becomes a seed of discovery, training, teaching, conferencing, and communicating if it is shared by several people.

Feasible applications include, but are not limited to, engineering or industrial design and evaluation, scientific visualization, medical diagnosis and training, medical analysis, surgery planning, and consumer devices such as 3D TV or games. A paper about IllusionHole is presented in SIGGRAPH 2001 Papers:
Interactive Stereoscopic Display for Three or More Users
Yoshifumi Kitamura, Takashige Konishi, Sumihiko Yamamoto, and Fumio Kishino.

www-human.eie.eng.osaka-u.ac.jp/IllusionHole



IllusionHole shared by four users. The fourth user's view of human brain analysis. Three brain images at lower column show the views of users standing at left, center, and right, respectively.

Informative Art

Juried Exhibit

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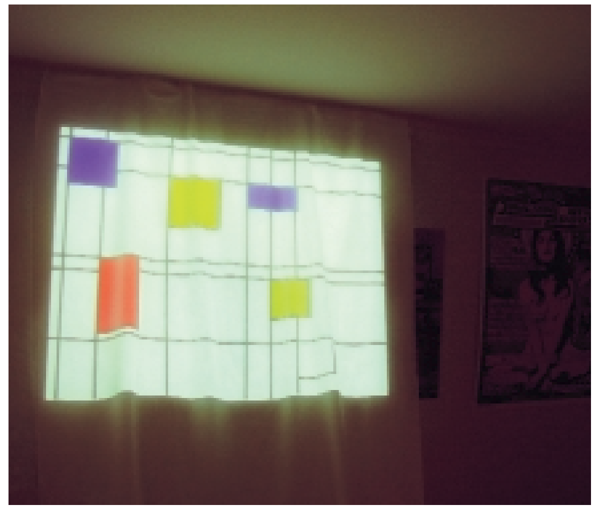
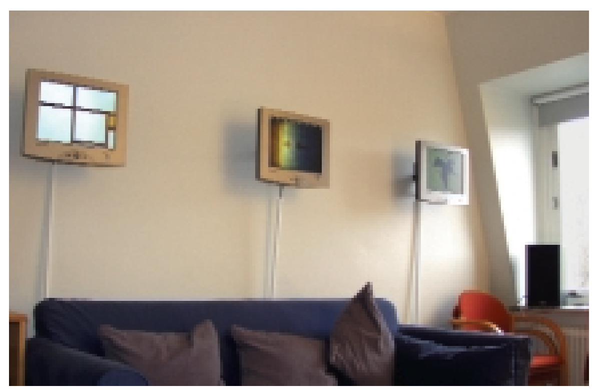
Computers are becoming ubiquitous, but traditional computer graphic displays do not lend themselves well to integration with everyday environments. The computer graphics of the future will need to blend in with the environment, yet at the same time provide opportunities for reflection and stimulation, much like traditional art. This is the motivation behind Informative Art.

Informative Art borrows from the "language" of traditional art (in particular non-figurative painting) to create computer graphic displays that convey some kind of dynamic information. For example, a wall-mounted screen showing geometrical figures reminiscent of the style of the painter Piet Mondrian might in fact be an information display that shows the amount of unread email for each employee in a workplace. In this project, we use several different examples of informative art pieces to show dynamic information from a variety of interrelated sources.

Reference
Redström, J., Skog, T., & Hallnäs, L (2000). Informative art: Using amplified artworks as information displays. In: *Proceedings of Designing Augmented Reality Environments* (DARE) 2000, ACM Press.



Dynamic Mondrian projected on a piece of hanging cloth.



Three pieces of informative art.

An Interface for Touching the Interface

Juried Exhibit

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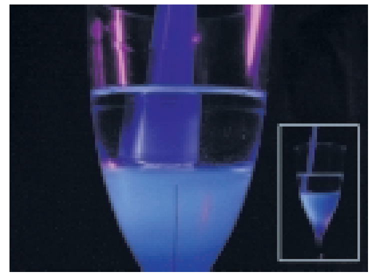
The word "haptization" means making it possible to touch. For example, haptic display devices allow users to touch computer-generated images. This process is often called haptization of information. Previous work on haptization is primarily focused on haptization of volume data produced by a CT scanner, a physical simulator, or a similar device. However, these systems haptize static or simulated information and are not effective in a real environment that changes dynamically.

Smart-Tool is a new haptization technology that combines real-time sensing devices with a haptic display. The sensor receives stimuli that change dynamically in a real environment and displays the information to the user through haptic sensation. Therefore, Smart-Tool makes it possible to touch the dynamic information of real environments in real time.

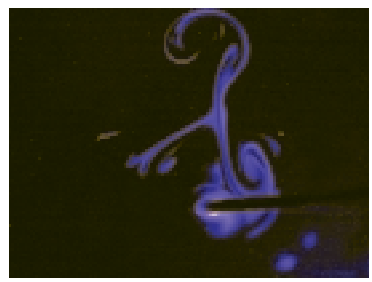
Conventional tools and sensors typically display sensor information visually, requiring the user to constantly monitor the display, interpret information, and take action based on these interpretations, which can be very inaccurate, especially in stressful situations. Redundancy through audio can improve perception, but is still often insufficient because it still relies on the interpretation process. Smart-Tool can assist by sensing the real environment and displaying haptic information. This force is not only a display method that alleviates interpretation of tactile information, but also supports the action of the user.

A quintessential application of this system is surgery. Surgeons use many kinds of tools to incise body tissue, like scalpels, scissors, etc. If the surgeon uses a scalpel enhanced with Smart-Tool technology, the real-time sensor on the scalpel can sense what kind of tissue the edge of the scalpel is touching and inform the user through haptic sensation. When the scalpel is in the proximity of vital tissues such as arteries or a pulsing heart, the Smart-Tool protects them from damage by sensing them and generating a repulsive force that can be naturally interpreted by a surgeon as virtually hard.

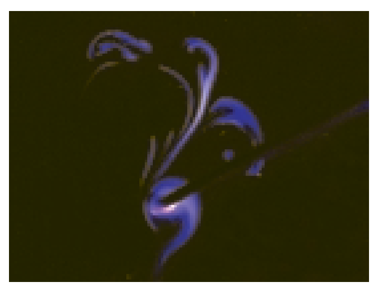
At SIGGRAPH 2001, the Smart-Tool system touches the interface between two liquids, which is usually impossible to feel. With Smart-Tool technology, the haptic sensation of the liquid interface is obtained from the tool's sensor and transmitted to the user directly in real time, providing an intuitive way to both analyze and act upon the interface.



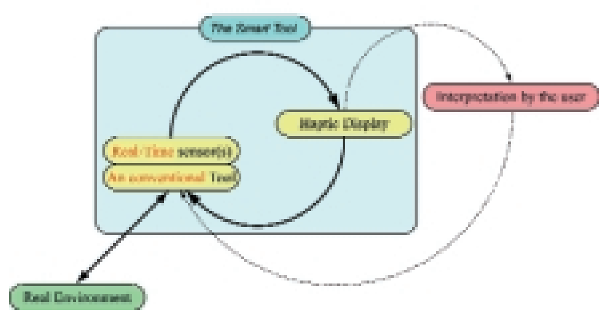
Touching the interface.



Marbling.



Marbling II.



Information flow.

Just Follow Me: A VR-Based Motion Training System

Juried Exhibit

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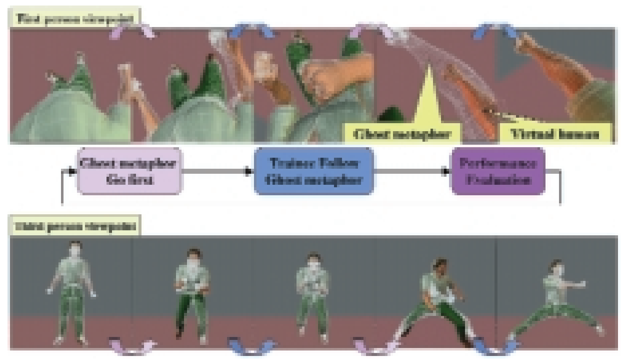
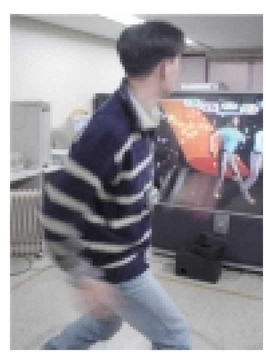
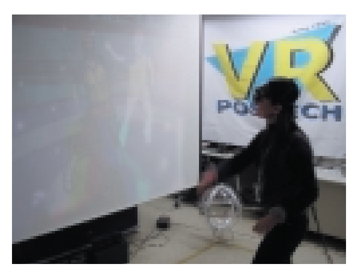
Training has been considered one of the most natural application areas of virtual reality (VR). This project demonstrates VR's utility for learning limb-motion profiles required in sports, dance, and the arts (for example, a golf swing, martial arts, calligraphy, etc.) The central concept, called Just Follow Me (JFM), is based on an intuitive interaction method called the "ghost" metaphor (Figure 1). Through the Ghost metaphor, the motion of the trainer is visualized in real time as a ghost (initially superimposed on the trainee) moving out of one's body. The trainee, who sees the motion from different viewpoints, is to "follow" the ghostly master as close as (or as fast as) possible.

The training process can be facilitated by showing other guidance cues (for example, the master's trail, annotations, etc.) and performance feedback (for example, indications of how well the trainee is following), and by adjusting the learning requirements (for example, relaxation of accuracy goals, restricting the motion's degrees of freedom). Evaluation results showed that JFM produced training and transfer effects as good as, and in certain situations better than, the real one. Thus when the system is reinforced and augmented with presence cues, more robust tracking and lighter head-mounted displays, and rich informative graphics and images, VR-based training methods will be attractive alternatives to the traditional "trainer-in-residence" or video-based motor-skill learning method.

The JFM system can be configured in many different ways. For the desktop/arcade version (Figure 2), it is difficult to effectively present the first-person viewpoint. Consequently, the ghost has been modified to what are called "sliding" ghosts; instead of showing continuous movement, discrete freezeframes of next imminent postures from fixed viewpoints (front, back, side) flow toward the dancing character to guide the motion (Figure 3). Another possibility is the "first-person viewpoint" version with the head-mounted display and head tracking, in which the original concept of the Ghost is used (Figure 4). The system uses four cameras mounted on the ceiling to track five highly reflective markers (worn on users' wrists, ankles, and belly). The tracked motion is compared to the reference motion for both online and offline evaluation. As trainees try to follow and imitate the character's dance on the screen, they get a feel for how well they are following the evaluations and corresponding special effects at the key posture frames, and they receive a final score at the end.







Meditation Chamber

Chair's Prerogative Exhibit

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Alternative therapeutic techniques related to relaxation and management of stress are increasingly employed to augment traditional treatment by drug-based, medical therapies. A vast body of results presented in the literature shows that these alternative treatments have great promise and warrant continued use and study. Drug-resistant epilepsy, hypertension, asthma, anxiety disorders, depression, and chronic pain are only a handful of the medical problems that have been successfully addressed through relaxation and meditation techniques.

Though the effects are not fully understood, these relaxation techniques are believed to stimulate production of certain important hormones. It has been demonstrated that experienced practitioners of transcendental meditation create in themselves the same endorphin-release reaction generated by physical exertion in experienced runners, often referred to as the "runner's high." It has also been shown that melatonin, thought to be important in health maintenance and prevention of diseases such as breast and prostate cancer, is found in significantly higher levels in regular meditators.

One roadblock to effective relaxation therapies is the consistency and quality of the experience. Not all formally trained physicians are trained to administer alternative treatments. Also, many people have difficulty with visual imagery and are not good candidates for meditation exercises.

The goal of this research is to design and build an immersive virtual environment that uses visual, audio, and tactile cues to create, guide, and maintain a user's guided relaxation and meditation experience. The virtual environment's design is based on current clinical best-practice techniques used for training and support of clients through a meditation or guided relaxation experience, such as: biofeedback electromyography, progressive muscle relaxation, guided meditation, and mindfulness meditation. We have explored various kinds of visual and audio experiences to evaluate which are most effective in promoting these relaxation techniques.

There are several possible advantages of using a virtual environment to support meditation and guided relaxation. Patients without good imaging skills can benefit from the use of meditation. Clinicians with minimal training in meditation and guided imagery are able to provide a consistent, high-quality relaxation and meditation experience for their clients. And, by providing specific meditation environments, we can guarantee that participants in future studies of the usefulness of meditation and relaxation techniques all receive identical training and treatment.

The collaborators thank the Graphics, Visualization, and Usability Center; the School of Literature, Communication, and Culture; and the College of Computing at the Georgia Institute of Technology for their support of this project.

Lotus position.

Installation concept.

Micro Archiving: Virtual Environments for Micro-Presence with Image-Based Model Acquisition

Juried Exhibit

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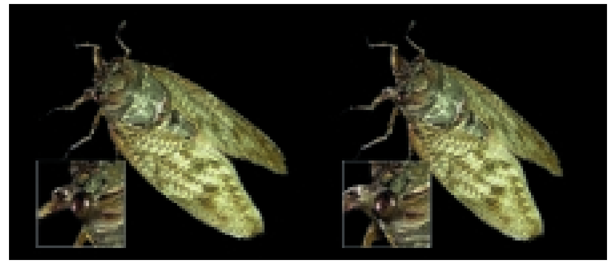
This experience allows visitors to visualize and interact with microscopic structures that cannot be seen with the naked eye, but that commonly exist in our everyday surroundings. Through a combination of Micro Archiving and virtual reality technology, it delivers an immersive virtual environment in which participants observe these microscopic structures in a private or collaborative workspace.

Micro-Presence is our term for the ability to experience these hidden realities. There are many terms that describe experiences of presence other than the real world, in which we feel something through our sensory organs directly. For example, Tele-Presence describes the technology that enables people to feel as if they are actually present in a different place or time. Micro-Presence is an environment in which participants feel as if they are tiny and can observe and interact naturally with things in the microcosmic world.

With Micro Archiving technology, it is possible to create high-definition virtual 3D models that are suitable for academic research in fields such as biology and zoology that require real observation of actual things. For educational use, this technology creates a high-definition multimedia space in which visitors can freely participate and interact with the exhibit.



Mobile Augmented Reality Systems

Juried Exhibit

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Augmented reality refers to using computers to overlay virtual information on the real world. Mobile Augmented Reality Systems (MARS) uses see-through head-worn displays with backpack-based computers developed by Columbia University and the Naval Research Laboratory, tracking technology developed by InterSense, and an infrared transmitter-based ubiquitous information infrastructure from eyeled GmbH. Our system creates a pervasive 3D information space that documents Emerging Technologies. It demonstrates some of the user interface techniques that we are developing to present information for MARS, including systems that adapt as the user moves between regions with high-precision six-degree-of-freedom tracking, orientation tracking and coarse position tracking, and orientation tracking alone.

As attendees wearing our systems walk around and near our installation, they are tracked by a six-degree-of-freedom tracker. The information they view is situated relative to the 3D coordinate system of the installation area. For example, an installation may be surrounded by virtual representations of associated material. In other parts of the installation area, tracking is accomplished through a combination of inertial head-and-body orientation trackers and a coarse position tracker based on a constellation of infrared transmitters. In those areas, information is situated relative to the 3D coordinate system of the user's body but is sensitive to the user's coarse position. As users move between areas of the installation area where different tracking technologies are in effect, the user interface adapts to use the best one available. Our infrared transmitters will also allow attendees to explore parts of the same information space with their own hand-held devices.

The MARS user interfaces embody three techniques that we are exploring to develop effective augmented-reality user interfaces: information filtering, user interface component design, and view management. Information filtering helps select the most relevant information to present, based on data about the user, the tasks being performed, and the surrounding environment, including the user's location. User interface component design determines the format in which this information should be conveyed, based on the available display resources and tracking accuracy. For example, the absence of high-accuracy position tracking would favor body- or screen-stabilized components over world-stabilized ones that would need to be registered with the physical objects to which they refer. View management attempts to ensure that the virtual objects that are selected for display are arranged appropriately with regard to their projections on the view plane. For example, virtual objects that are not constrained to occupy a specific position in the 3D world should be arranged so they do not obstruct the view of other physical or virtual objects in the scene that are more important.

We believe that user interface techniques of this sort will play a key role in the MARS devices that people will begin to use on an everyday basis over the coming decade.

Acknowledgments
MARS research at Columbia University is funded in part by ONR, NSF, and gifts from IBM, Intel, Microsoft, and Mitsubishi. MARS research at NRL is funded in part by ONR.

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www.cs.columbia.edu/graphics/projects/mars
ait.nrl.navy.mil/vrlab/projects/BARS/BARS.html
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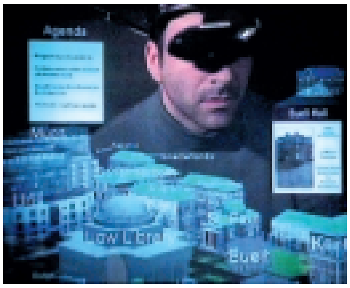
www.isense.com



View management in a collaborative MARS user interface for exploring a virtual campus model imaged through one user's head-worn display. Building labels and documentation surrounding a second user are dynamically arranged to avoid obscuring other buildings and the second user's head.

Mobile augmented reality system with stereo see-through head-worn display. Inset shows user's view after information filtering for route-finding task.

Origami Desk

Chair's Prerogative Exhibit

With Origami Desk, users learn to fold paper into beautiful shapes. It improves on the inscrutable origami diagrams we all know and love by showing videos that demonstrate what the hands should do, projecting lines onto the paper to indicate where the folds should be, and monitoring the paper folding to give budding origami artists feedback if their folding should go awry.

Origami Desk utilizes projection, electric field sensing, and low-cost radio-frequency identification tags to enable computer users to break free from the CRT-keyboard-mouse interaction paradigm. These technologies allow interactions in the user's space, eliminating the need for metaphoric mapping between the digital world and the physical world. Electric field sensing detects where a user's hands are by measuring capacitance over the work surface. Coupled with the visual interface, this sensor allows dynamic mapping of digital buttons and handles.

Origami Desk breaks new ground in the RF-tagging domain by measuring changes in the resonant frequencies of electromagnetic foil patterns embedded in the origami paper. The coils are coupled to create certain shifts in frequency as the origami paper is folded. These readings in turn allow the computer to infer and provide feedback on whether the user has properly completed the folding step. The projected workspace is delineated into three types of spaces that help choreograph the user's actions and prevent occlusion or inadvertent triggering of commands: interaction areas, display areas, and work areas.

Origami Desk is a powerful embodiment of how real-world graphics, interaction design, and innovative sensing technologies can be pragmatically integrated to create interactive environments centered around the active human user.

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Jenn Yoon

Interaction design
Wendy Ju

Electrical field-sensing engineering
Rehmi Post

RF engineering
Matt Reynolds

Our thanks to Neil Gershenfeld, Michael Hawley, and Kent Larson for making this collaboration possible.

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OttoAndIris.com

Chair's Prerogative Exhibit

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Zoesis Studios

OttoAndIris.com is a playful theme park filled with fun activities in a 3D world. The core elements of the park are two interactive characters, Otto and Iris. These characters are constructed using animation, believable agent, and interactive drama technology developed by Zoesis Studios, a spin-off from Carnegie Mellon University's Oz project, which has focused on these research areas since 1987.

Many commentators have speculated about combining Silicon Valley and Hollywood. We believe the most powerful form of this combination will be true interactive stories, where viewers can enter into a world, be substantially free to do whatever they want, and still experience *the* powerful dramatic story that the author intended. We believe this new art form will be extremely popular and will have a full range of forms, from mass market entertainment to conceptual art.

The two core elements of this new art form are interactive characters that seem truly real and story technology that can subtly guide the experience to fulfill the author's intent. OttoAndIris.com was designed to advance the first of these: the art and technology of interactive characters. In the course of its development, advances were also made in interactive story guidance and interactive music.

Participants enter the world using the display and mouse. The display shows a first-person view of the world from the user's current location, and the mouse moves the person's virtual hand in the 3D world. Users also hear music, sound effects, and character voices. As they explore OttoAndIris.com, they can play tag with Otto and Iris, help Otto sing some operas, create costumes with Iris, or participate in several other activities with the characters.

Each character responds immediately to the user's virtual hand, the user beyond the screen, and the other character. This response is appropriate for the character's current situation, limited perception, resource-bounded reasoning, current goals, and current emotions. Every moment-to-moment reaction and self-motivated action is also specific to the personality and individuality of the character as created by their authors.

In the Magic Snowball scene of OttoAndIris.com, a drama management system provides subtle guidance to create a dramatic arc of intensity, while at the same time maximizing how much of Otto's personality is seen by the user during the interaction. An interactive music system in this scene adjusts the music according to the emotions of the characters and position in the dramatic arc.

OttoAndIris.com is deliverable over the Web to machines that were purchased during Christmas 1997 or later. It requires no special software, plugins, or high-speed connections. Using normal modems and Web browsers, participants can simply go to the OttoAndIris.com URL, and start to play.

Helping Otto sing an opera.

Playing tag with with Otto and Iris.

Pirates!

Chair's Prerogative Exhibit

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Pirates! is a mobile, multi-user, location-aware computer game that runs on PDAs and is experienced in physical space. The game world is a fantasy archipelago where each player takes the role of a pirate captain. Game objectives include solving missions, making landfall on islands, searching for treasures, trading commodities, and battling other players at sea.

The game is played with proximity-sensing handheld devices that take advantage of, and rely upon, players' mobility as an intrinsic part of the game structure. Each handheld device has a custom short-range radio beacon that identifies when players encounter each other in the physical world. A corresponding encounter is triggered in the virtual world, which enables player-to-player game activities such as battles. Radio beacons distributed throughout the gaming area represent islands that can be explored when approached. Thus walking between different locations in the room becomes equivalent to sailing between islands in the virtual world.

The handheld devices function as thin clients and use a wireless network to connect to a central game server. The server controls the overall game mechanics, such as missions and inventories, and determines the result of the players' actions through the user interface. This allows for dynamic update of the user interface, graphics, sounds, and game rules. The game server also provides an overall game status that is presented on a large public display.

Pirates! was designed to be played in a social setting, encouraging face-to-face interaction between players and non-players alike, and promoting movement and exploration within a defined physical space. Unlike most computer games, playing Pirates! depends just as much on social interaction with people in the real world as on the computer-mediated game play. Rather than continuously gazing at the screen, players have to navigate a social environment to move within the virtual environment and exchange information with other players, or even people not playing the game, to win the game.

On-screen graphics showing Phoenix birds attacking a player at an island.

Two Pirates! players closely engaged in battle.

Riding the Net
Juried Exhibit

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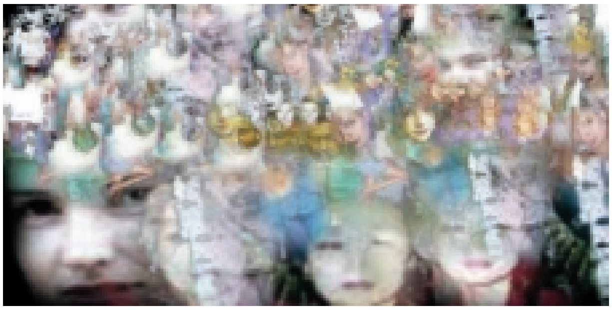
Riding the Net presents a novel approach to browsing the Internet in a more intuitive, playful, and entertaining fashion. While two users talk and communicate with each other, keywords of their communication are picked up by the system's speech-recognition engine. These keywords are then used to search and download corresponding images from the Internet. When users, for example, speak about "houses" or "flowers," different images of "houses" or "flowers" are downloaded. As there is usually a vast amount of images available for each keyword, users see new image icons constantly retrieved from the Internet. All images are then collectively displayed in 3D in the system's interactive window and streamed from the respective view of each user. As images come from either the left or right side of the screen, they all stream toward each other before they leave the screen and are replaced by new images derived from new keywords spoken by the two users. The entire image scenario on the window surface constantly changes, since it is a direct interpretation of the users' dialogue and communication with each other.

Both users can also touch the image icons on the screen: this halts the images temporarily so users can look at specific image icons in more detail. When they do this, the exact URLs for these specific image icons can be downloaded onto a separate computer screen, so users can find out where the images came from and what they refer to.

Riding the Net provides an entertaining and playful way to browse the Internet, and users become intensively engaged in the vast amount of visual information available from and presented by the system. Users can control the content of what they are watching through their own decisions, dialogue, and interaction.

Technical Description

- Three Pentium III PCs including NVIDIA GeForce2 high-speed graphic cards
- One Internet 100/10baseT hub
- One LCD projection unit: high-resolution LCD projector with true 1280 x 1024 resolution
- One window-detection frame, including IR sensors
- One window-detection interface
- One space construction (approx. 3 x 3 meters), including window glass surface and two chairs
- One graphic software system
- One interface software system
- One speech-recognition and image-retrieval software system



Riding the Net
Christa Sommerer, Laurent Mignonneau, and Roberto Lopez-Gulliver Interactive Web-based image browser developed at ATR MIC Labs. Interface design support: Stephen Jones.

RobotPHONE: RUI for Interpersonal Communication

Juried Exhibit

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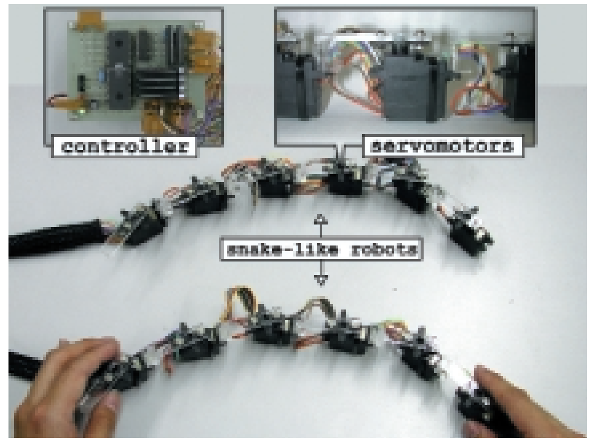
For a long time, robots have been imagined as industrial machines that perform work that humans want to avoid. However, considering the characteristics of their physical embodiment, robots can also be recognized as interfaces for human beings. Using a robot as an interface between the real world and the information world can be referred to as a robotic user interface (RUI). Other good examples include: intelligent robots that act as artificial-intelligence agents and haptic-feedback robot arms used in VR systems.

RobotPHONE is an RUI system for interpersonal exchange that uses robots as shape-sharing agents for physical communication. The shape and motion of remote shape-sharing devices are always synchronized by a symmetric bilateral control method. Robot movements, such as modification of posture or the input of motion, are reflected to the remote end in real time. RobotPHONE users can communicate and interact with each other by exchanging the shape and motion of the robot.

An initial prototype based on the RobotPHONE concept has two snake-like robots for a shape-sharing device. Each snake-like robot has six parallel axes, which form a right angle with the long side of the snake's body. Therefore, range of body movement is limited to the 2D plane, but the body itself represents a shape that can be easily modified by hand.

To make the system more user-friendly for everyone, a second RobotPHONE system that looks like a teddy bear was integrated with a voice-communication system. When users communicate with this system, the teddy bear acts as a physical avatar, so it was very important to give the teddy bear-like robot a shape and a system of degrees of freedom that are very similar to human characteristics. Since users can treat the teddy bear-like robot just like an ordinary teddy bear, this system is very easy to use. If users move the teddy bear's head, hands, or legs, the movements are transmitted to the opposite side. Just as the teddy bear placed in front of the user is an input device, it is also a display device that displays the status of the remote robot. In other words, while each teddy bear acts as an avatar of the user who sits in front of it, it also seamlessly acts as an avatar of the user at the remote side. A mother giving her daughter a stuffed doll to keep her company at night is a form of communication aided by a physical entity. RobotPHONE allows this kind of remote communication not by attempting to transmit users but rather a virtual substitute on their behalf.



Snake-like robots and controller.

Teddy bear-like robots.

Movements of shape-sharing devices.

sensingChair
Juried Exhibit

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The sensingChair introduces a seat that feels its occupant through a layer of "artificial skin." As a new input device, it opens up new opportunities for human-computer interactions. In an automobile, for example, a sensingChair can detect whether the seat is occupied and estimate the weight and size of its occupant. This information can be used to automatically control the car's airbag deployment force. In a teleconference scenario, a sensingChair allows users to zoom in on the remote speaker by leaning forward or pan the remote camera by shifting weight to the left or right. In an office environment, a sensingChair can be a posture coach that monitors the sitting postures of its occupants and detects bad habits such as slouching. For interactive graphic displays, a sensingChair allows one to control certain aspects of a graphic display through body movements.

Pressure sensing in the sensingChair is made possible with a commercially available pressure distribution measurement system. Two sensor sheets, placed inside green protective covers, are surface-mounted on the seat and the back rest of an office chair (Figure 1). The data generated by these sheets, in the form of two 42-by-48 8-bit arrays, can be spliced and visualized as a 2D or 3D pressure-distribution map. For example, Figure 2 is a 3D display of the pressure distribution associated with the posture "sitting upright." The front and back halves of the pressure map correspond to the pressure in the seat and the back rest of the chair, respectively.

The sensing Chair is presented in three scenarios:

1. Visualization of pressure map. As a person moves in the chair, the changing pressure distribution is visualized as terrain with picture, plain terrain profile, and input for a dynamic image.

2. Sitting posture classification. A PCA-based static posture classification system labels an occupant's sitting posture in real time. The output of the classification system is used to select an image that represents someone sitting in a chair with the corresponding posture.

3. Chair-driven computer games. The sensingChair is used as an intuitive interface that allows its user to engage in computer games by leaning and shifting weight in the chair. Information derived from pressure readings (for example, center of force) is used to control several PC Electronic Arts games.

Figure 1. The sensingChair.

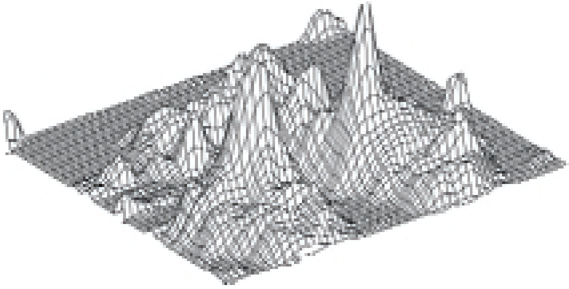

Figure 2. A 3D view of pressure distribution for "sitting upright."

Ultra-Bright Ultra-High-Resolution Reality Center

Chair's Prerogative Exhibit

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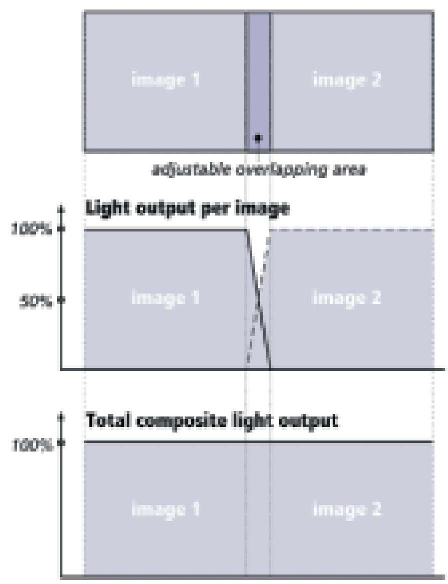
The Ultra-Bright Ultra-High-Resolution Reality Center demonstrates the latest developments in simulation-based digital light-valve projection technology. The goal is to provide an insight into the future of light-valve projection technologies and their use in high-end, multi-channel projected displays.

Since the first multi-channel, curved-screen Reality Center was installed in Reading, England, in 1994, CRT technology has been utilized almost exclusively as the projection source, primarily because several simulation-based modifications are required for high-end, multi-channel, curved-screen displays, and only CRT projectors have been able to deliver these technologies.

In contrast to the historical norm, this Reality Center installation employs extremely bright high-resolution LCD projectors modified with many of these same simulation-based optimizations that, in the past, have been applied only to CRT projection technology. This high-tech marriage obviates the need to limit ambient light and creates a Reality Center without walls, opening up multi-channel, curved-screen displays to larger audiences and greater collaboration than was previously possible.

Much of the technology demonstrated here represents prototype-stage developments from the R&D department of BARCO Simulation Products. Some of the advancements (such as True Motion Reproduction, Transport Delay Reduction, Color Gamut Matching, and Micro Lens Array options) are available commercially in a mature form. However, several other optimizations that are implemented in this Reality Center (such as the Advanced Geometry Correction and Optical Soft-Edge Matching) represent truly emerging technologies. Each is revealed in its current preliminary version, and each is still in development for eventual commercial applications.

The Advanced Geometry Correction implemented for SIGGRAPH 2001 (called "Warp6" by BARCO Simulation Products) enables electronic generation of complex distortions without any frame delay. Warp6 is implemented within each LCD projector to conform the image data so that the image appears undistorted on a curved screen. Optical Soft-Edge Blending enables this multi-channel display to have a single seamless display between channels. This edge blending is accomplished within the projector's optical path to reduce the black level in the overlap zone while maintaining a full dynamic range.



Optical Soft-Edge blending is achieved by modulation of the light output in the overlap zone so that the total light output in that zone equals the light output of the rest of the image.

WARP 6 is a non-linear image mapping processor in SXGA resolution. It is optimized to preserve fine detail in the image and reduce aliasing to an absolute minimum, using bi-cubic interpolation algorithms and a highly advanced processor board.